Current Status of the ERBS Nonscanner SW Data Record from 10/1999 to 08/2005

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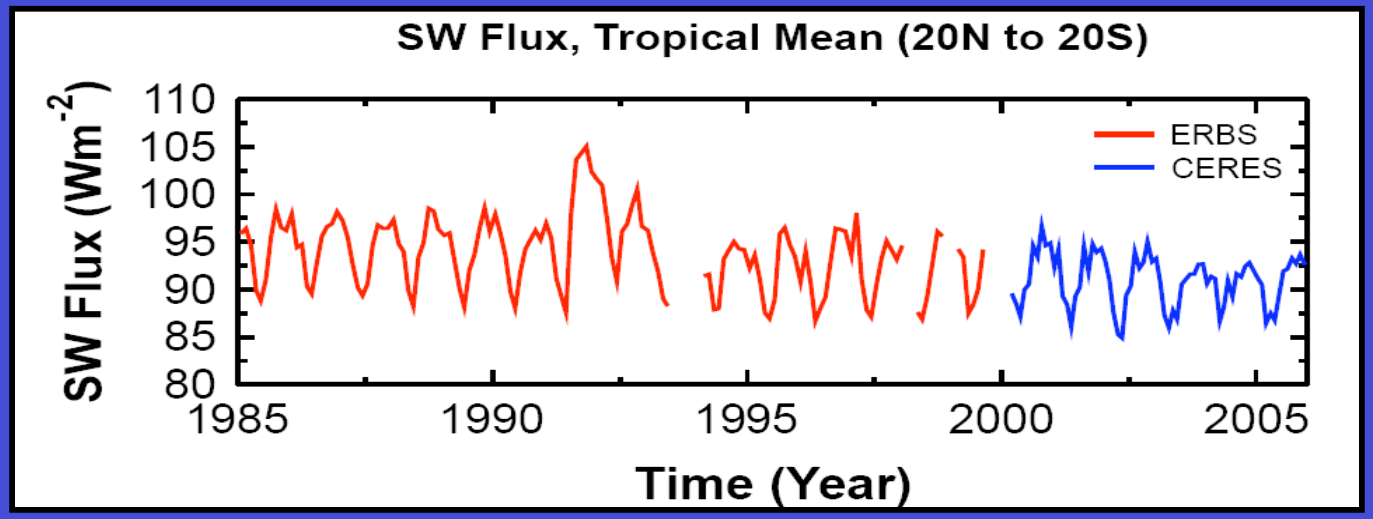
The Problem

- The current top of atmosphere (TOA) broadband SW climate record from 1985 to 2005 is broken up into two segments (ERBE/ERBS: 1985 to 1999 and CERES/Terra: 2000 to present) due to the 5-month data gap between 10/1999 and 2/2000
- Without overlapping data, we can't tie these two SW climate segments together due to absolute calibration and time sampling differences between these two satellite missions



The Solution

- Develop simple method to connect these two SW segments together

  1) Direct method: Use ERBS SW data from 10/1999 to 8/2005

     - However, ERBS instrument anomaly on 10/5/1999 has not been corrected and data after 10/1999 is not currently useable for climate study. Works on correcting this instrument issue is on-going

  2) Indirect method: Use other stable climate data source (i.e., SeaWiFS PAR data) to guide the transition from the ERBE/ERBS SW nonscanner record to the CERES/Terra SW scanner record (Loeb et al., J. Climate., Feb 2007)

     - Give promising results

Outlines

- Give an overview on the current status of the ERBS Nonscanner SW data record from 10/1999 to 8/2005

  1) Provide a description of the ERBS instrument anomaly and how it affects the SW record

  2) Highlight steps that we have taken over the last 8 months to recover the last five years of ERBS data

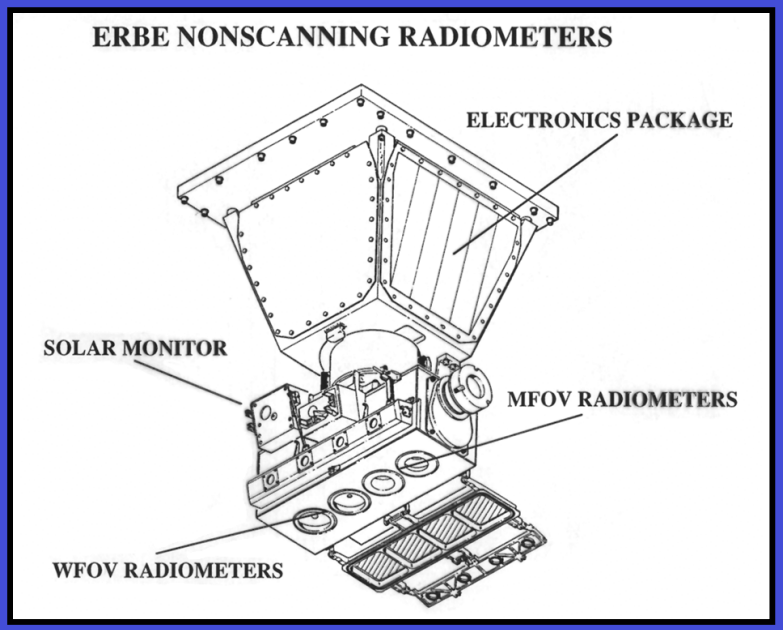
     - Establishing instrument calibration after instrument anomaly
     - Determination of the instrument tilt angle
     - Reworking the inversion algorithm to account for (a) the tilt of the instrument and (b) the additional decreases in satellite altitude

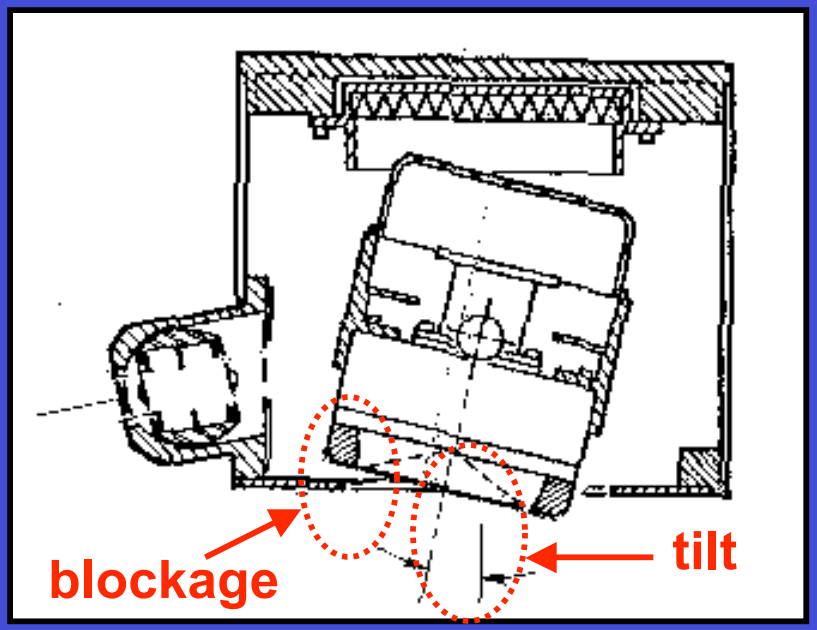
  3) Show initial SW results based on the new algorithm for 10/99 to 7/02

  4) Summarize future works that are needed to release this last ERBS SW record

Description of the ERBS Instrument Problem

- ERBS instrument anomaly occurred on 10/5/1999 at the end of its normal calibration event. It stopped at an angle away from nadir. Consequently, new science algorithm will have to be developed and tested to remove this instrument tilt anomaly artifact from the ERBS scientific data after 10/5/1999

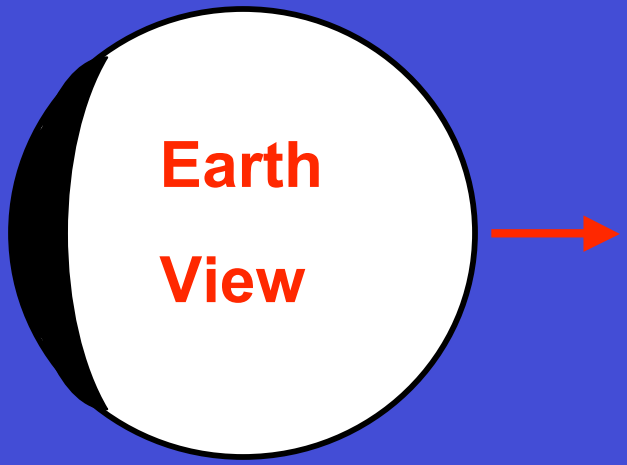


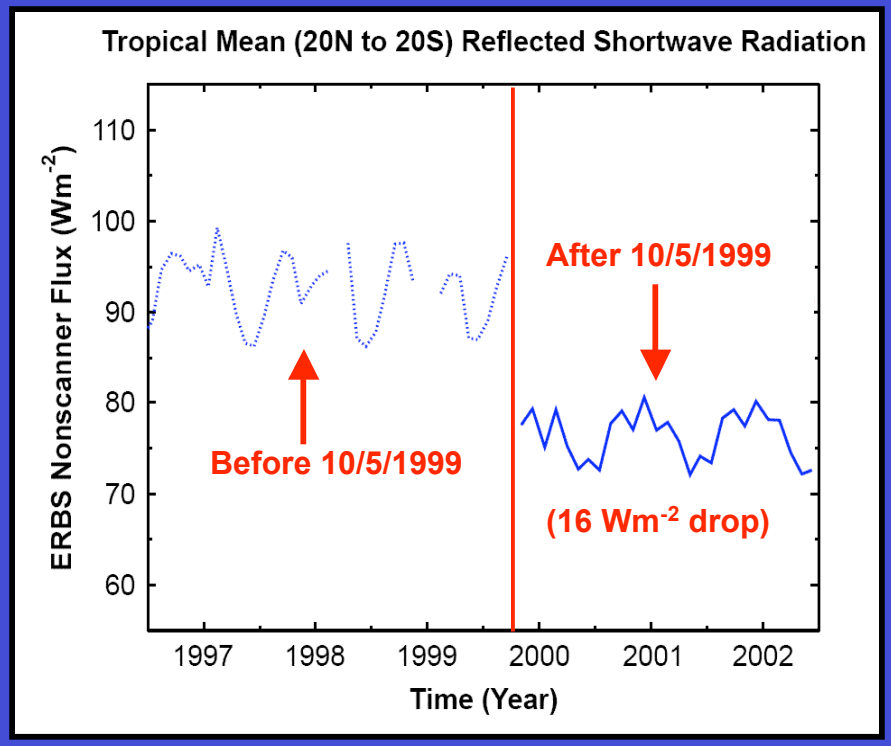


Instrument Tilt Anomaly Artifact

- The effect of the instrument tilt anomaly, if not corrected, will appear as a sharp drop in the reflected shortwave fluxes after 10/5/1999

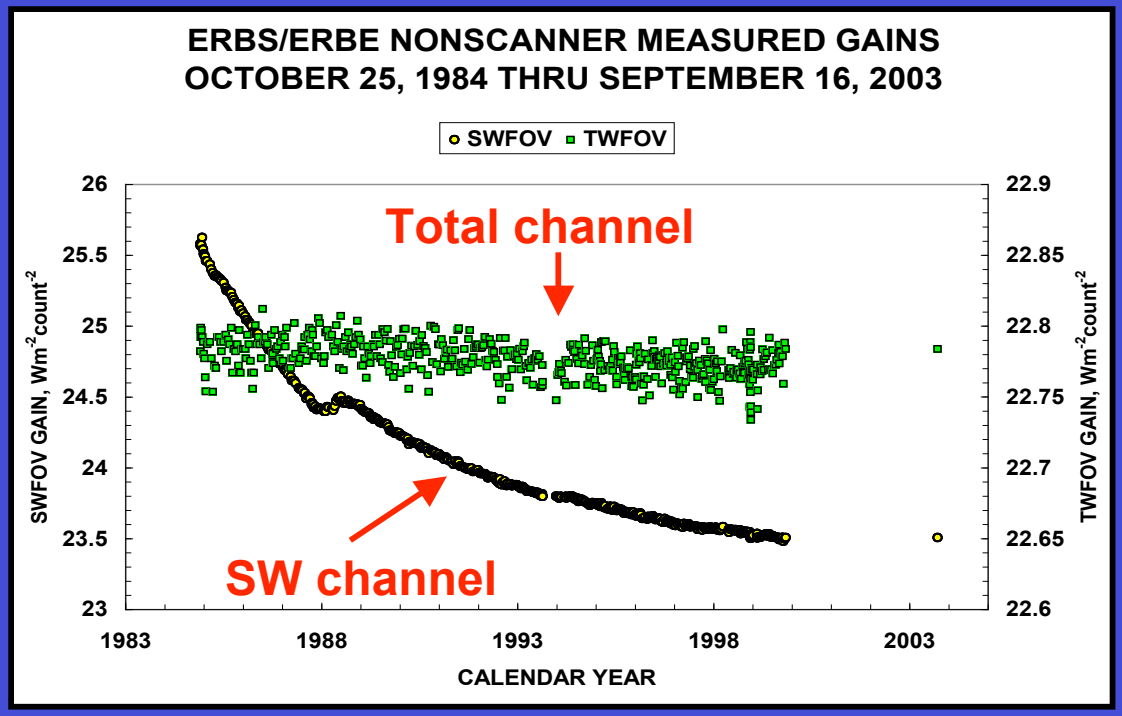
ERBS Earth-viewing footprint with tilt sensor





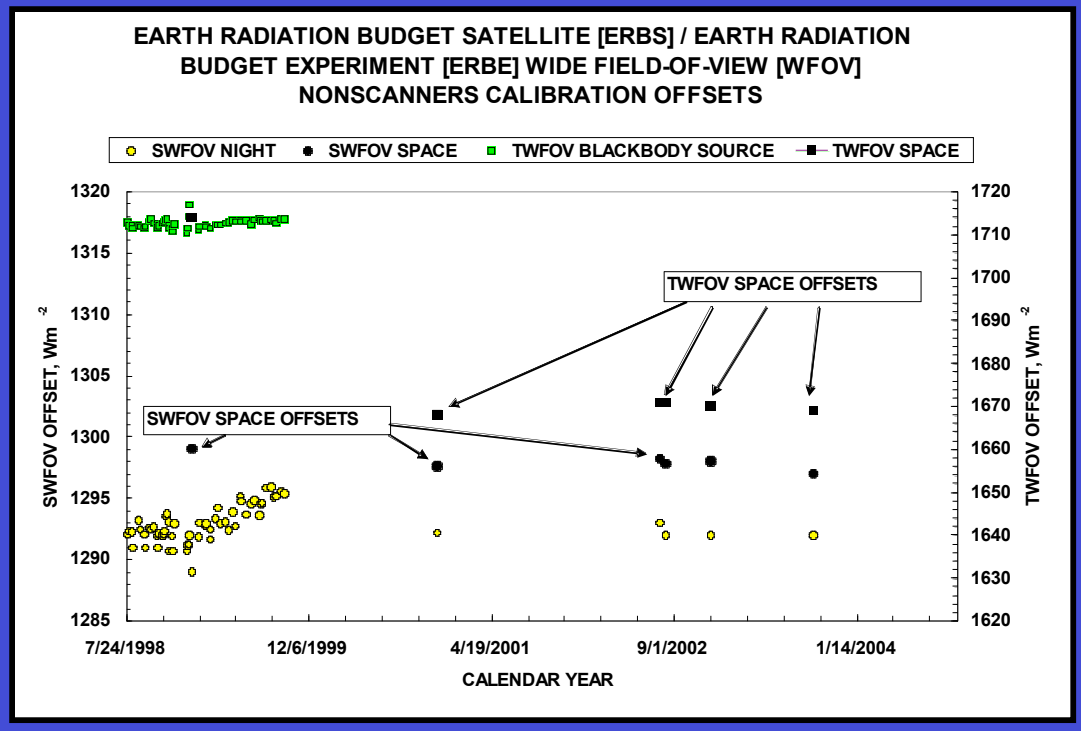
Instrument Calibration (Gain)

- ERBS nonscanner instrument calibration was re-established through special spacecraft pitch maneuver on 9/16/2003 by looking directly at the Sun
- Nonscanner SW sensor gain was essentially unchanged between 9/1999 and 9/2003



Instrument Calibration (Offset)

- ERBS nonscanner instrument calibration was re-established through special spacecraft pitch maneuver on 9/16/2003 by looking directly at the Sun
- Nonscanner SW sensor offset was essentially unchanged between 9/1999 and 9/2003



Instrument Tilt Angle Determination

- The tilt angle is defined by the directions between the ERBS non-scanner optical axes and the spacecraft nadir. This angle is critical for removing instrument artifact in the TOA SW fluxes

Total Solar Irradiance (Wm^{-2})

Date	Total	SW
~11/21/1984	1371.5	1353.1
*11/21/1984	1373.7	1354.0
~10/20/1985	1368.2	1330.5
*10/20/1985	1368.5	1330.9
~12/04/2002	1317.7	1194.3
*09/16/2003	1375.1	1247.0

~ Azimuth setting of 0 degree

* Azimuth setting of 90 degrees

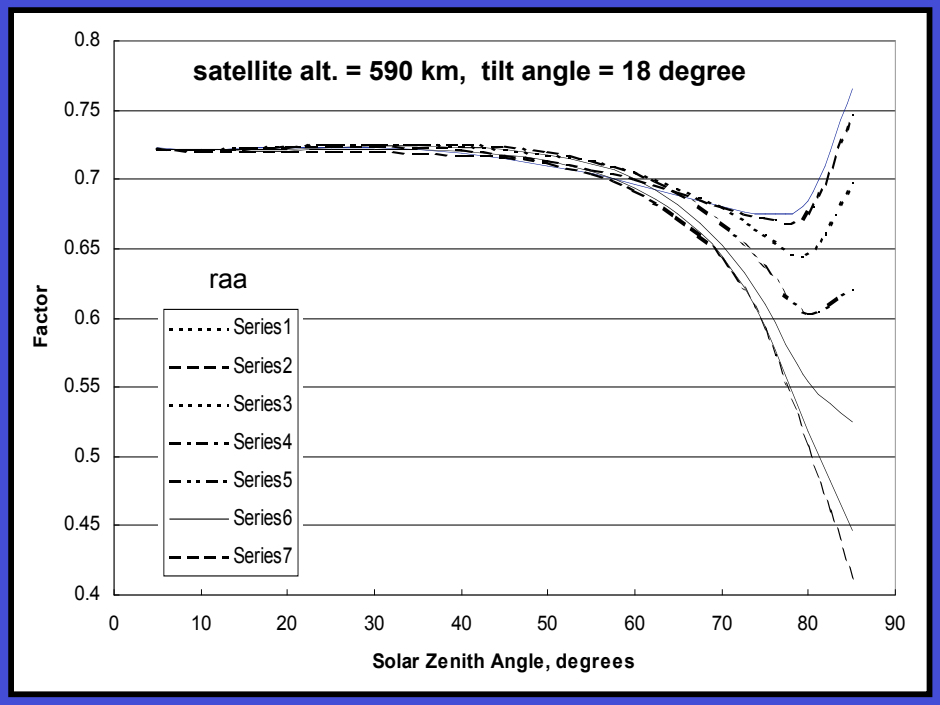
$$\text{Tilt Angle} = \text{Cosine}^{-1} (TSI_{2002} / TSI_{2003})$$

	Total	SW
Tilt Angle (Degree)	16.6	16.7

Consistent to within 0.1 degree

ERBS Nonscanner SW Inversion

- ERBS SW inversion algorithm inverts the SW measurement at satellite into SW flux at top of the atmosphere (TOA)
- SW_{toa} is determined by SW_{sat}, instrument tilt angle (ta), satellite altitude (alt), solar zenith angle (sza), and satellite relative azimuth angle (raa)

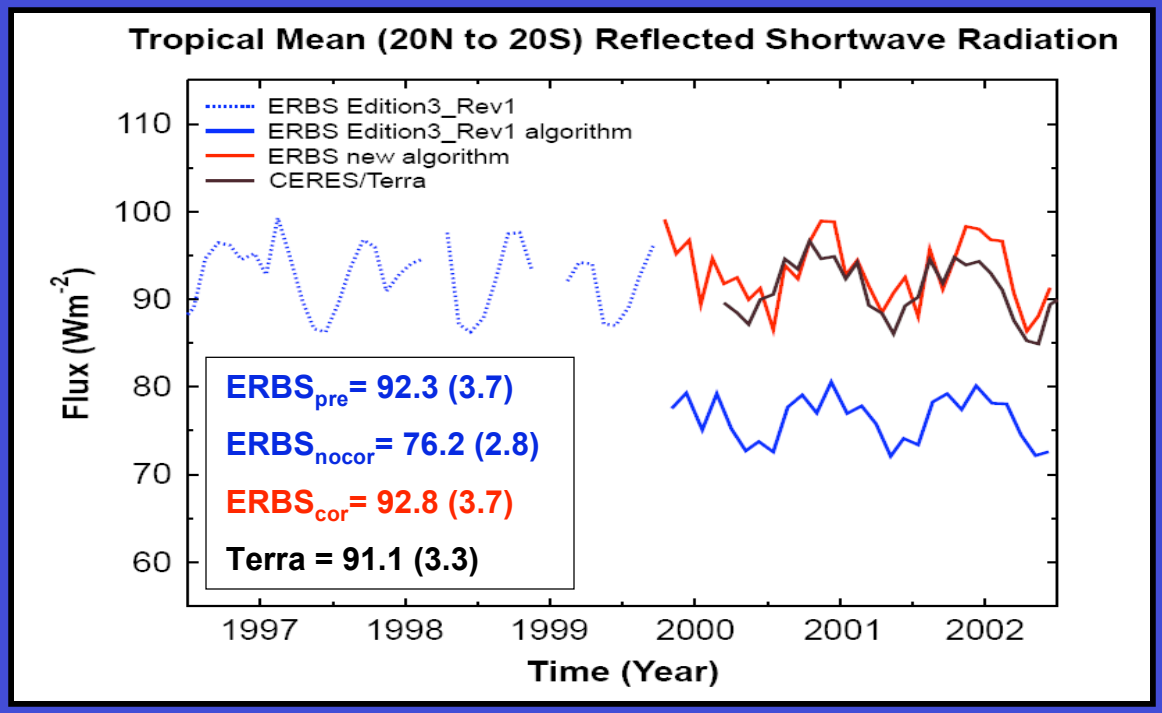


$SW_{toa} = SW_{sat}$ / Factor (ta, alt, sza, raa)

	9/30/1999	10/6/1999
Factor	0.86	0.72

The lower value of the inversion "Factor" will increase the SW_{toa}

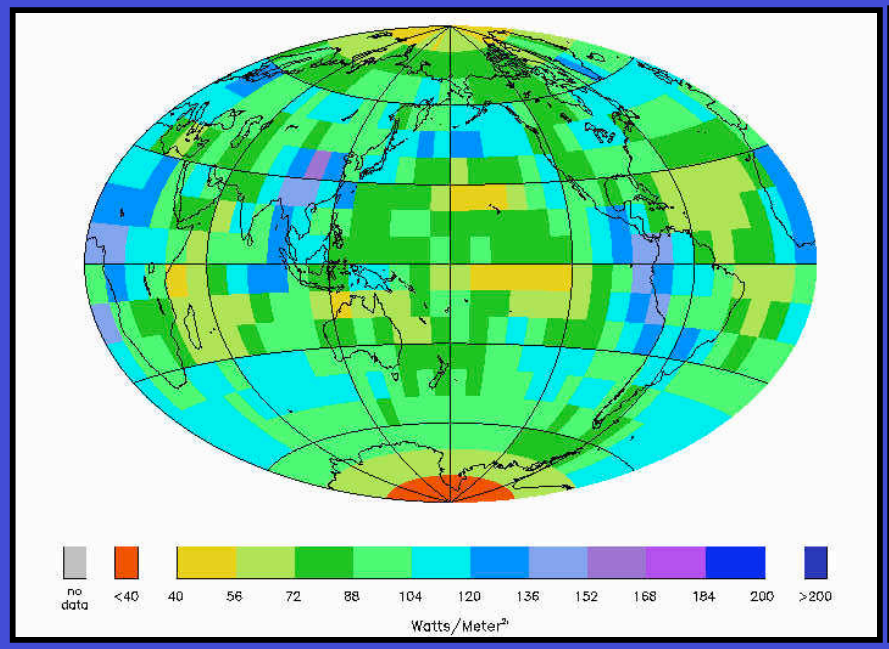
Tropical Mean Reflected Shortwave Radiation



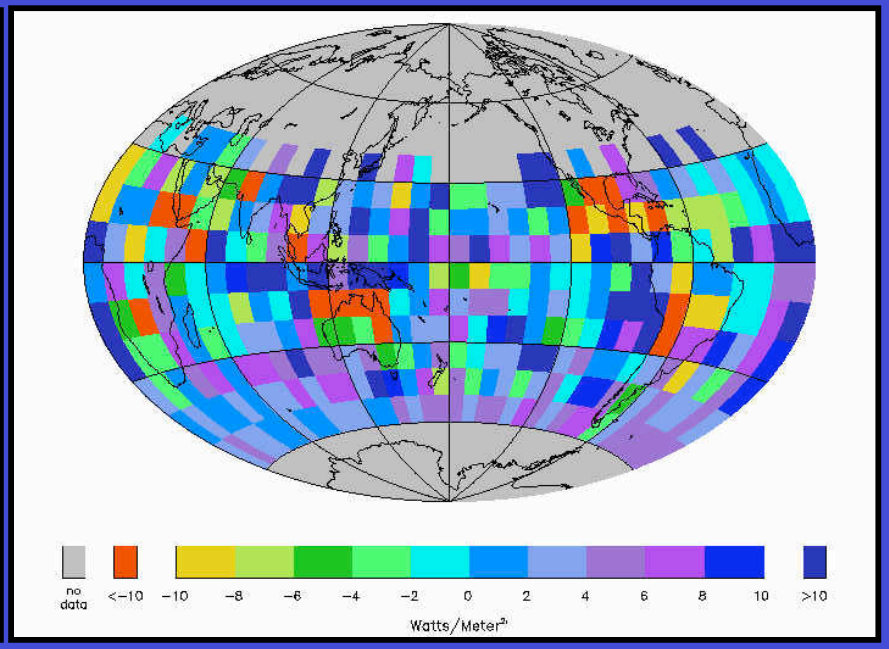
- The new algorithm moves the ERBS post-anomaly time series back to the same radiometric level as the the pre-anomaly data
- The recovered ERBS Nonscanner time series also matches well with the overlapping CERES/Terra scanner data

Monthly Mean Comparison, September 2001

CERES/Terra ERBE-like



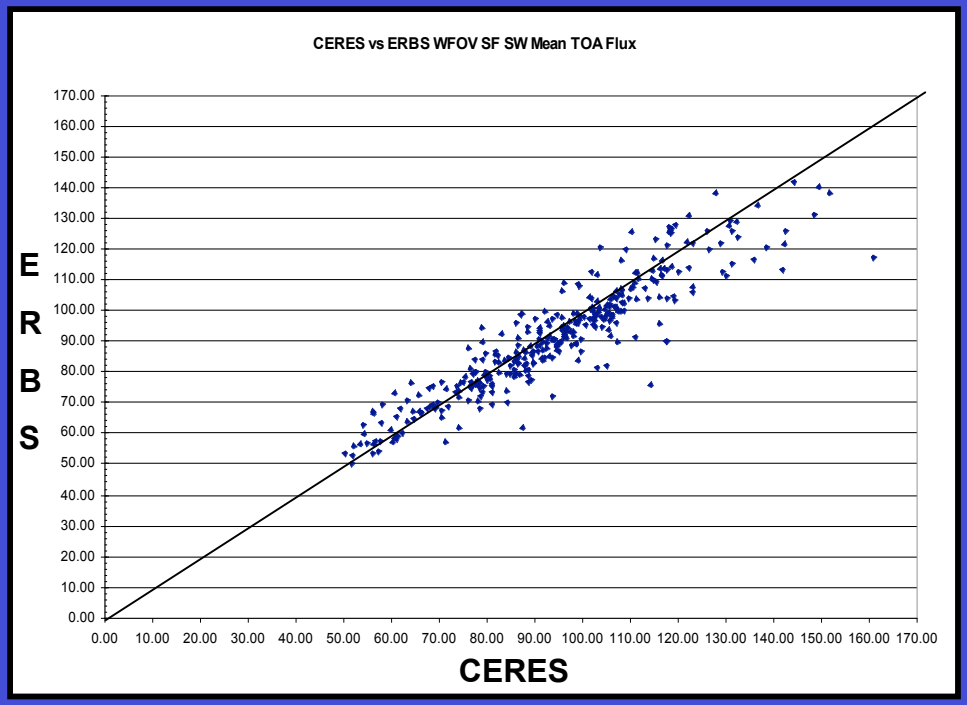
CERES minus ERBS



Time	CERES	ERBS NS	Difference
09/2001	94.5 (21.1)	92.8 (19.2)	1.7 (7.9)

Monthly Mean Comparison, September 2001

CERES/Terra ERBE-like SW vs. ERBS SW



Time	CERES	ERBS NS	R^2	Slope	Offset
09/2001	94.5 (21.1)	92.8 (19.2)	0.92	0.84	13.4

Summary and Future Works

- The recovery of the ERBS SW record from 10/1999 to 8/2005 is currently underway with some promising initial results
- Additional works are needed to determine the uncertainty of the tilt angle and how this will affect the quality of the final SW time series
- Further validation activities are required to map the CERES vs. ERBS SW differences as a function of both the instantaneous and the temporal sampling differences and to determine whether these are consistent with previous studies
- ERBS nosncanner SW data from other months also need to be examined for data quality issues
- Finally, future work will be needed for the recovery of the ERBS total channel data record, if funding permits
- This work was funded by the ERBS end-of-mission funding